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**Environmental and Economic Evaluation of the Massachusetts  
Smoke-free Workplace Law**

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## Evaluation of Smoke-free Workplace Law

**Abstract** An environmental and economic evaluation of the smoke-free law in Massachusetts provides a broad appreciation of how a state-wide smoking ban affects the health of patrons and workers as well as the industries that are commonly concerned about the effects of smoking bans on business. The aim of this study is to evaluate environmental and economic effects of the statewide Massachusetts statewide Smoke-Free Workplace Law. Before and after the smoking ban, air quality testing was conducted in a sample (n=27) of hospitality venues and state-wide economic changes were assessed. Compliance, in terms of patronage was measured by person-counts. Environmental outcomes were respirable suspended particles (RSP) less than 2.5 microns in diameter (PM<sub>2.5</sub>). Economic outcomes were meals tax collections, employment in the food services and drinking places and accommodations industries. On average, levels of respirable suspended particles (RSPs) less than 2.5 microns in diameter (PM<sub>2.5</sub>) decreased 93% in these venues after the Massachusetts Smoke-free Workplace Law went into effect. No statistically significant changes were observed among the economic indicators. This evaluation demonstrates that the state-wide Massachusetts law has effectively improved indoor air quality in a sample of Massachusetts venues and has not negatively affected several economic indicators.

**Keywords:** Smoking · Tobacco smoke pollution · Occupational exposure · Economics · Legislation and jurisprudence

### **Introduction**

Anti-smoking efforts have increasingly focused on promoting clean indoor air and implementing comprehensive smoking restrictions in public places. On July 5, 2004, the Massachusetts Smoke-Free Workplace Law went into effect, making Massachusetts the sixth state to ban smoking completely in all workplaces, including restaurants and bars [1]. A number of states have passed statewide smoke-free legislation, despite opposition and claims that such laws are associated with detrimental economic effects (2, 3).

Dangerous health effects of secondhand smoke exposure have been well-established. (4, 5) They are of particular concern in hospitality establishments because workers have the highest rates of exposure and the lowest levels of protection [6-9]. Tobacco smoke results in substantial emissions of pollutants that are suspended in the air known as respirable suspended particulate (RSP) matter [4, 10 11]. Specifically, a class of RSPs known as PM<sub>2.5</sub> (i.e. particulate matter less than or equal to 2.5 microns in diameter) pose higher health risks because they can easily be inhaled deep into the lungs. Air quality as measured by RSP levels relative to smoking bans is a well-established evaluation strategy [12-14].

Although the tobacco industry and front groups have consistently opposed smoke-free legislation directly and indirectly [2, 15-17], research suggesting that legislation has had negative effects on economic indicators have been based on weak evaluation approaches lacking validity [18, 19]. Numerous studies have examined the economic effects of community and regional smoke-free policies in the US and internationally, indicating the absence of any negative effects and suggesting possible positive effects [2, 20]. For example, published research indicates that local smoke-free policies in

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Massachusetts did not impact charitable gaming (e.g. bingo) and restaurant business [21, 22]. While most previous studies have focused on effects at the local and community level, few statewide evaluations have been conducted [23-25].

Comprehensive smoke-free laws have proven to be an efficient and effective approach to eliminating exposure to secondhand smoke in hospitality venues [26-28].

Few if any studies have taken a more comprehensive evaluation approach by combining statewide economic data with indoor air measurement. The purpose of this research was to assess the change in indoor air quality that occurred in a sample of hospitality venues before and after the law; determine compliance with the law after implementation; and evaluate economic changes before and after the law, including patronage, sales revenue, and employment rates.

### **Methods**

#### Air Quality

RSP (PM<sub>2.5</sub>) levels were measured in a convenience sample of hospitality venues two weeks before (pre-ban) and 4-5 weeks after (post-ban) implementation of the indoor smoking ban. Venues were selected from five Massachusetts towns that either did not have a smoking policy or that had a very weak smoking policy in effect prior to the implementation of the state-wide ban. Two establishments that were included in the pre-law measurements were closed indefinitely leaving 27 establishments that were visited both pre- and post-law, representing the final comparable sample. Ten establishments were classified as free-standing bars and seventeen as restaurants with bars.

In each establishment, RSPs were measured using a TSI SidePak AM510 Personal Aerosol Monitor (TSI, Inc., St. Paul, MN), an aerosol monitor fitted with a 2.5

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$\mu\text{m}$  impactor in order to measure the concentration of particulate matter with a mass median aerodynamic diameter less than or equal to  $2.5 \mu\text{m}$ , or  $\text{PM}_{2.5}$ . The Sidepak was used with a calibration factor setting of 0.32. This was determined by calibrating the Sidepak with another laser photometer that had been calibrated for SHS and used in previous studies [11]. Light scattering photometer devices have proven to be an effective air monitoring device in similar studies [11, 12].

Data collection occurred in two stages: pre-law and post-law. For both stages, each hospitality establishment was visited one time. Data collection occurred on Friday through Wednesday, between 6:45 PM and 1:15 AM, for an average of 35.3 minutes. Pre-law measurements were taken between June 23 and June 29, 2004, and post-law, between October 27 and December 1, 2004. Data collectors placed the air monitor in a computer bag, and entered each establishment sitting at a central location. The monitor was placed on a table, on the bar, or on a bar stool so that the air sampled was within normal breathing zones. Sampling was discreet in order not to disturb the occupants' normal behavior.

The main outcome measure to assess the indoor air quality in the hospitality establishments was the change in respirable suspended particles (RSP) less than 2.5 microns in diameter ( $\text{PM}_{2.5}$ ) from pre-law to post-law. Observations were made at three different times in each establishment to determine the number of people present and the number of burning cigarettes. The first observation was made immediately upon entering an establishment, and the second and third observations were made in subsequent 15-minute intervals. The volume of each venue was measured using the Zircon DM S50 Sonic Measure (Zircon Corporation, Campbell, California).

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For each establishment, the first and last minute of RSPs recorded were discarded because they were averaged with the air from outside and from entryways. The remaining data points were averaged to create a mean  $PM_{2.5}$  measure within each establishment. TrakPro Version 3.41 (TSI, Inc., St. Paul, MN) was used to upload data from the SidePak for analysis and to create graphs. For each establishment, the numbers of people present and burning cigarettes were averaged for data analyses. The smoker density was calculated by dividing the average number of burning cigarettes by the room volume of the establishment.

### Compliance

To assess compliance with the smoking ban after implementation, the number of burning cigarettes in each establishment was observed and recorded during post-ban data collection periods. These observations were validated with the air monitor, as the monitor would reveal a spike in  $PM_{2.5}$  if smoking had indeed occurred outside the observation parameters.

### Economic Indicators

Economic indicators used in the present study are based on state revenue and expenditures data, employment information, as well as other indicators of business activity in the relevant industries. Monthly meals tax, and total sales and use tax collections were obtained from the Massachusetts Department of Revenue (DOR) [29]. Sales and use taxes refer to a 5% tax that the Massachusetts DOR applies to sales, rental, or use of personal tangible property. Monthly employment figures for the leisure and hospitality industries were obtained from the Current Employment Statistics (CES) Survey published by U.S. Bureau of Labor Statistics [30].

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Monthly meals tax collections in the year following implementation of the law (July, 2004 – June, 2005) were compared with the previous monthly meals tax collections from January 1999 through June 2004 using linear regression analysis. Secular trend and seasonality were controlled for in the regression model with variables for time (number of months), and season (i.e. Winter: December – February, Spring: March – May; Summer: June – August; Fall: September – November) Total sales and use tax collections were included in the model to control for general economic trend.

The numbers of workers employed per month in food services and drinking places and accommodations industries in the year following implementation of the law were compared with the previous numbers of workers employed per month in these industries from January 1999 to July 2005 in separate linear regression analyses. The North American Industry Classification System (NAICS) codes for these industries are 722 and 721, respectively. Secular trend and seasonality were controlled for in the regression model with variables for time (in months) and season (Winter: December – February; Spring: March – May; Summer: June – August; and Fall: September – November). The numbers of Massachusetts workers employed in service provider industries (NAICS supersector code 07) and the total number workers who were employed in food services and drinking places or accommodations in the 44 states without comprehensive statewide clean indoor air laws in place by the end of the study period were included as controls for general economic trend during the corresponding months.

Change in the average monthly sales or employment figures for each of the outcome measures was tested by the significance of the variable representing the presence or absence of the ban (“Ban”). Change in trend was assessed by the significance



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of the interaction term between time and the presence or absence of the law (Time\*Ban). Variables statistically significant at  $p \leq 0.05$  or having a confounding effect on any of the remaining coefficients were included in the respective final regression models.

Analyses were performed using Stata (StataCorp. 2005. *Stata Statistical Software: Release 9*. College Station, TX: StataCorp LP).

### **Results**

#### Air Quality

A total of 27 establishments were revisited after the law went into effect. On average, levels of respirable suspended particles (RSPs) less than 2.5 microns in diameter ( $PM_{2.5}$ ) decreased 93% in these venues after the Massachusetts Smoke-free Workplace Law went into effect (Figure 1). Additionally, the smoker density changed from 0.89 burning cigarettes per  $100m^3$  to 0.00 after the implementation of the law. Prior to the state-wide smoking ban, burning cigarettes were observed in 27 of the 29 establishments visited. (93%)

#### Observed Compliance

After implementation of the law, one burning cigarette was observed in 3.7 % (n=1) of the establishments. This establishment was observed to have one smoker with a burning cigarette, who was subsequently asked by a peer to put his cigarette out.

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### Economic Evaluation

#### Patronage

Patronage in the restaurants and bars visited during this study was slightly higher following implementation of the law (37.9 persons per venue) than prior to the law (34.9), although this increase was not statistically significant ( $p = 0.609$ ).

#### Meals tax

Meals tax collections and sales and use tax collections exhibit seasonal patterns (Figure 2). Regression analysis controlling for season shows that monthly meals tax collections were unchanged ( $p=0.241$ ) and no change in trend occurred with implementation of the law ( $p=0.240$ ) (Table 1).

The numbers of Massachusetts workers monthly since the year 2000 in the food services and drinking places and accommodation industries are shown in Figures 3, 4, 5 and 6. Both food services and drinking places employment and accommodations employment exhibited seasonal fluctuations. Regression analysis controlling for these showed no statistically significant changes in the numbers of workers employed in food services and drinking places ( $p=0.680$  or the trend in employment ( $p=0.683$ ) (Table 2) with the ban. The numbers of workers employed in the accommodation industry in Massachusetts was higher ( $p=0.003$ ) following the ban, but the effect was not statistically significant ( $p=0.905$ ) with the addition of the interaction variable. The interaction between time and the presence or absence of the ban was also not statistically significant ( $p=0.926$ ), which indicates no significant change in trend occurred following the ban.

### **Discussion**

This evaluation demonstrates that the state-wide Massachusetts law has effectively improved indoor air quality in a sample of Massachusetts venues and has not negatively impacted leisure and hospitality revenue and employment in Massachusetts. Indoor air monitoring results indicate that, on average, levels of RSPs decreased 93% (206  $\mu\text{g}/\text{m}^3$  to 14  $\mu\text{g}/\text{m}^3$ ) in a sample of 27 venues after the law took effect. These findings are consistent with other studies that have examined changes in air quality to evaluate the impact of smoking legislation [12, 13].

Patronage in study establishments did not change between pre and post-law measurements. Analyses of economic data prior to and following implementation of the law demonstrated that the Massachusetts state-wide law did not negatively affect state-wide meals and alcoholic beverage excise tax collections. Furthermore, no significant changes occurred in the absolute numbers of employees or trends in employment in food services and drinking places or accommodations industries.

Compliance data suggests that workplace owners are observing the Massachusetts law indicating successful implementation. Within five months of the law's implementation, study findings indicated that 96.3% of the establishments were compliant with the smoking ban. These findings are supported by a recent report by the Massachusetts Department of Public Health, which approximates compliance rates between (87%-91%) based on random inspection, response to complaints, and on-site observations [31].

Limitations of this study should be noted. First, air measurements were conducted in a small convenience sample of hospitality establishments and therefore may not be

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representative of all hospitality venues without local smoking bans in Massachusetts. However, establishments that constituted a range of sizes, genres (from local pubs to trendy restaurants), and locations were selected in an effort to collect data from a representative sample of hospitality establishments. Second, secondhand smoke is not the only source of indoor levels of  $PM_{2.5}$ . Other sources such as ambient particle concentrations and cooking also contribute to the indoor particle levels. However, smoking is the main contributor to indoor air pollution; once the state-wide smoking ban went into effect,  $PM_{2.5}$  levels decreased 93% indicating that cigarette smoke heavily contributed to the RSP levels prior to the implementation of the ban.

Despite important limitations, many factors contributed to the validity of the evaluation. First, a sensitive air monitor was used to sample air in an unobtrusive manner so employees were less likely to change their behavior by asking patrons not to smoke during post-ban measurements. Establishments were visited at a variety of times to increase the internal validity. In addition, for pre- and post-law measurements, establishments were visited on the same day of the week, at the same time of night, and for approximately the same amount of time, making the measurements more comparable, and potentially reducing the effects of possible confounding variables.

Economic findings in this report are subject to at least one important limitation. Before the state-wide law was implemented, many Massachusetts towns and cities had previously enacted complete and partial local smoking regulations (approximately 30% and 40% respectively). This study did not account for economic differences between towns and cities with various levels of local regulations prior to the implementation of the state-wide law. Nevertheless, data and methods used in the economic analyses did meet

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important criteria for validity. The data were objective, collected routinely by independent government agencies, and covered the periods of several years before and one year after the implementation of the law. Regression techniques were used to control for secular trends, seasonality, as well as economic trends, using total sales and use tax collections in analyses of revenues and total workforce in analyses of employment.

Study findings underscore the importance of comprehensive smoke-free policies and dispute arguments that such laws result in negative economic effects. Even without much preparatory time from the signing to the implementation of the Massachusetts law, workplace owners are complying with the law. Although state-wide smoking bans are gaining momentum, a predominance of states are yet to adopt them and secondhand smoke continues to be a public health danger. Policy efforts need to be redoubled at this time, justified by continuing evidence as presented here that environmental and public health benefits can be expected without negative economic cost.

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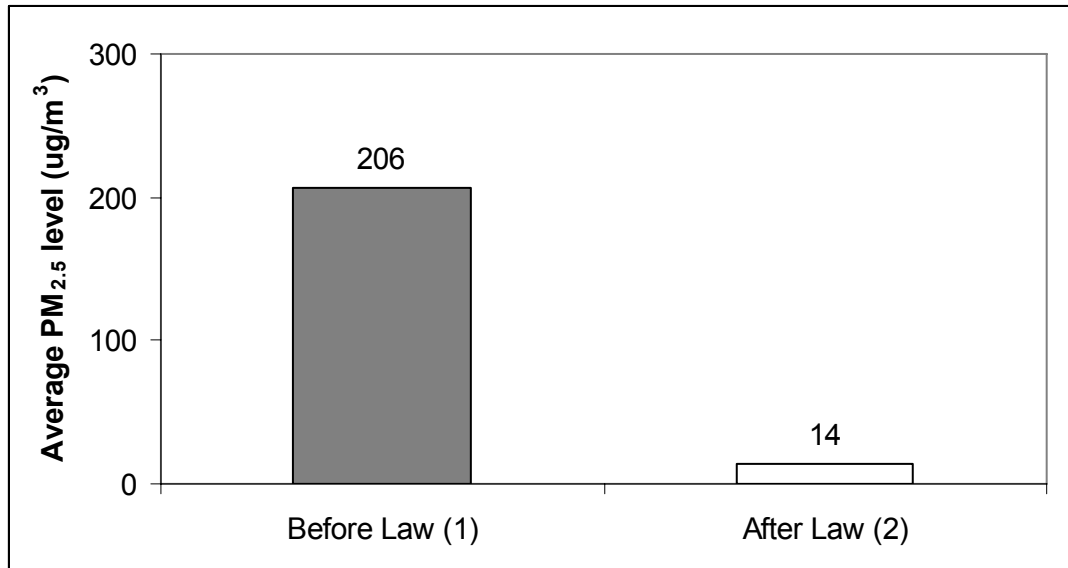
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**Figure 1 Average level of indoor air pollution in Massachusetts establishments before and after the law**

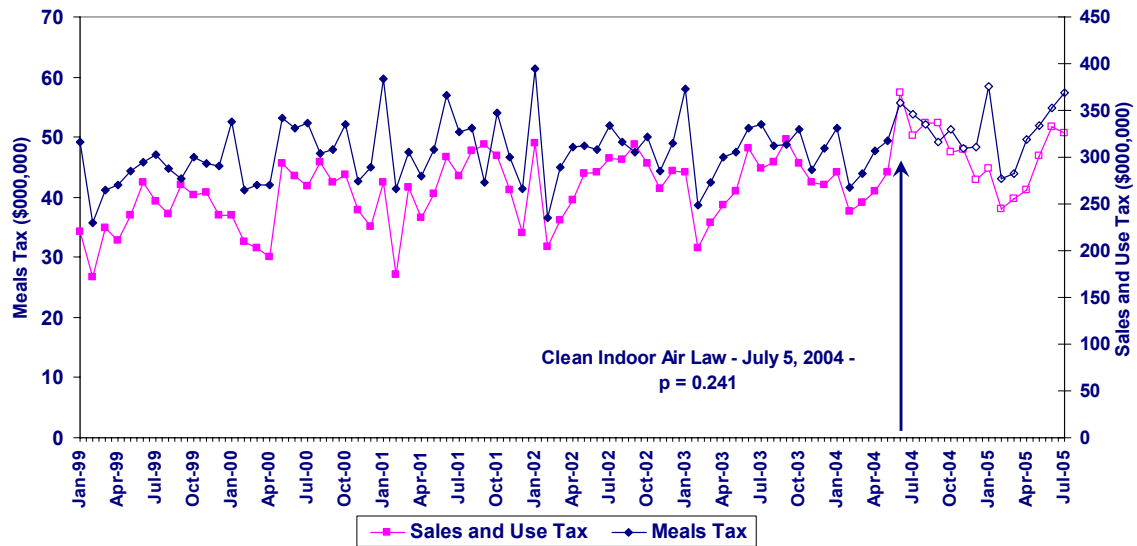


Fine Particle Air Pollution in All Massachusetts Venues, June 23, 2004 to December 1, 2004

- (1) 29 venues sampled before Massachusetts smoke-free law went into effect
- (2) same 27 venues sampled after Massachusetts smoke-free law went into effect (2 venues were closed)

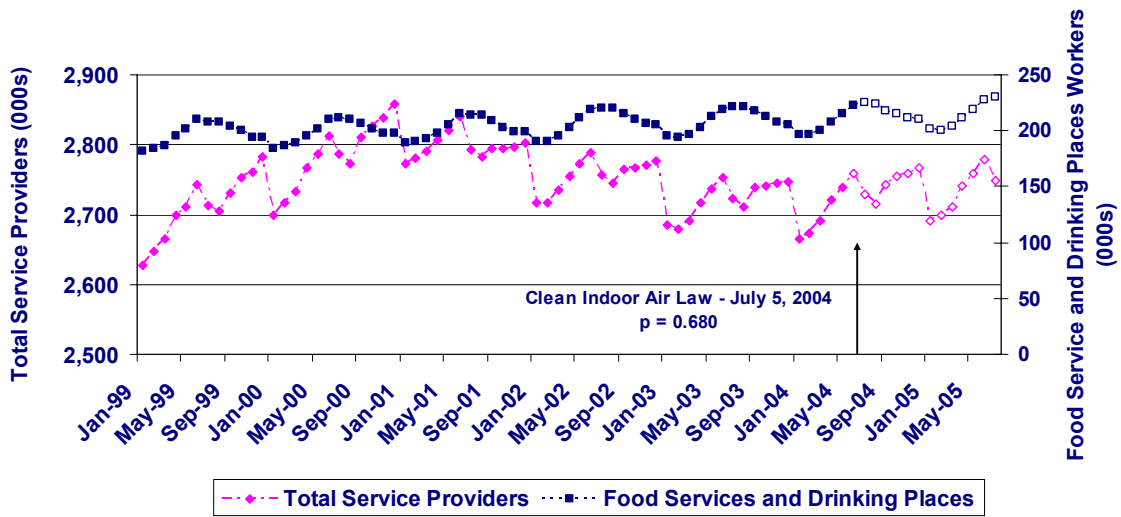
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**Figure 2 Massachusetts monthly meals tax collections**



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## Figure 3 Food services and drinking places employment in Massachusetts



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Figure 4 Food services and drinking places employment in Massachusetts and states without clean indoor air laws

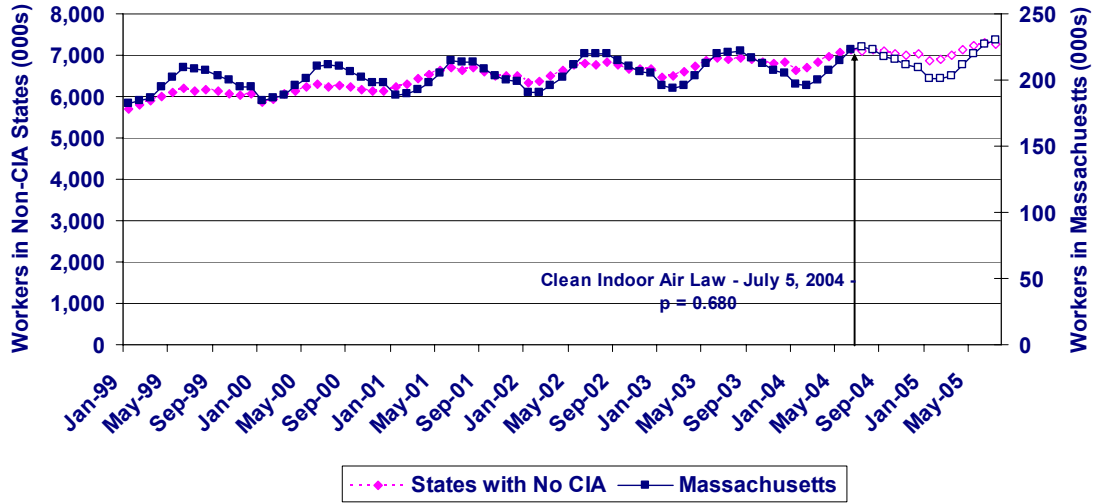
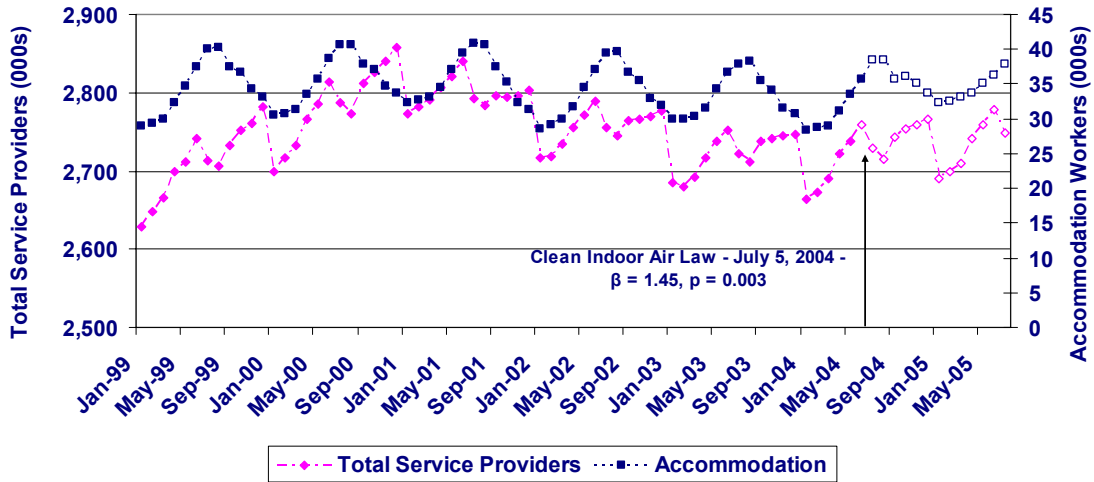
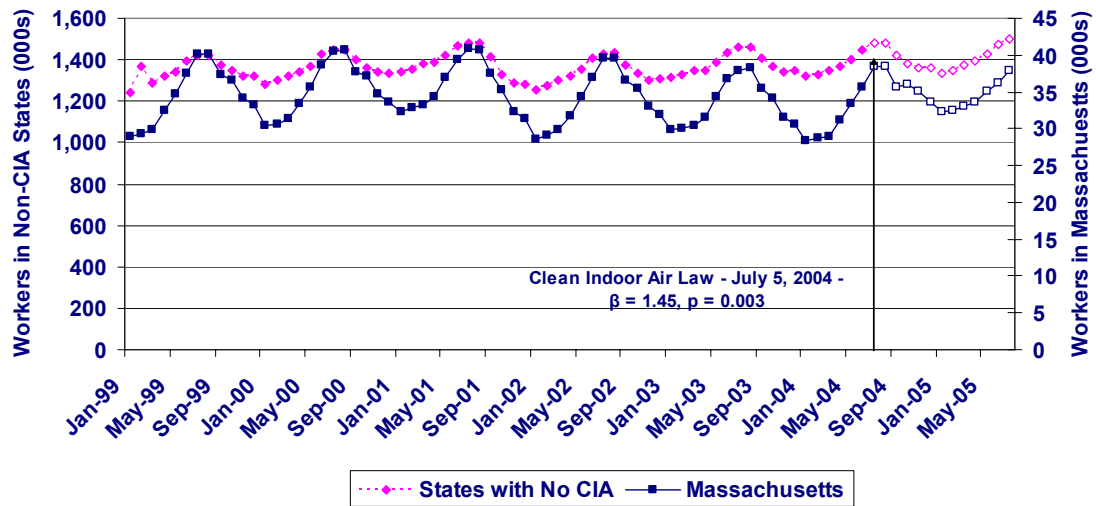


Figure 5 Accommodations industry employment in Massachusetts



**Figure 6 Accommodations industry employment in Massachusetts and states without clean indoor air laws**





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**Table 1 Regression of Monthly Massachusetts Meals Tax Collections**

	$\beta$	t	P-value
Sales and Use	.0975999	9.82	0.000
Time (months)	3.171375	5.71	0.000
Season 2	1849.644	2.30	0.025
Season 3	5900.806	6.95	0.000
Season 4	6520.741	7.82	0.000
Ban	140993.7	1.18	0.241
Time*Ban	7.270156	-1.18	0.240

Sales and Use = Sales and Use Tax Collections; Season2= Spring, Season3= Summer, Season4= Fall. Time = number of months; Ban = presence or absence of smoking ban in MA. Time\*Ban = Interaction of time and ban; Adjusted R-Square = .8205.

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**Table 2 Regression of Massachusetts Food Services and Drinking Places Employees**

	$\beta$	t	P-value
US Employees	.0355205	8.18	0.000
Season 2	.738882	0.58	0.565
Season 3	11.65896	7.04	0.000
Season 4	6.867828	5.51	0.000
Time (months)	-.0106218	-4.37	0.000
Ban	-62.89049	-0.41	0.680
Time*Ban	.0039243	0.42	0.673

US Employees = Food Service and Drinking Places employees in all states except CA, CT, DE, MA, ME, and NY. Season2= Spring, Season3= Summer, Season4= Fall Time = number of months; Ban = presence or absence of smoking ban in MA. Time\*Ban = Interaction of time and ban. Adjusted R-Square = 0.9129.

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**Table 3 Regression of Massachusetts Accommodations Employees**

	$\beta$	t	P-value
US Employees	.032543	7.10	0.000
SP Employees	.0145065	4.50	0.000
Time (months)	-.0015595	-6.24	0.000
Season 2	.3984862	1.00	0.322
Season 3	3.113296	4.61	0.000
Season 4	2.344414	5.53	0.000
Ban	6.431128	0.12	0.905
Time*Ban	-.0003033	-0.09	0.926

US Employees = Accommodations employees in all states except CA, CT, DE, MA, ME, and NY. SP<sub>MA</sub> Employees = MA Service Provider employees; Season2= Spring, Season3= Summer, Season4= Fall. Time = number of months; Ban = presence or absence of smoking ban in MA. Time\*Ban = Interaction of time and ban; Adjusted R-Square = 0.8994.